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SALEM

MICRO-CONTROLLER + DSP-BASED SOLID STATE ALL ELECTRONIC THREE-PHASE TRI-VECTOR ENERGY METER

OVERVIEW

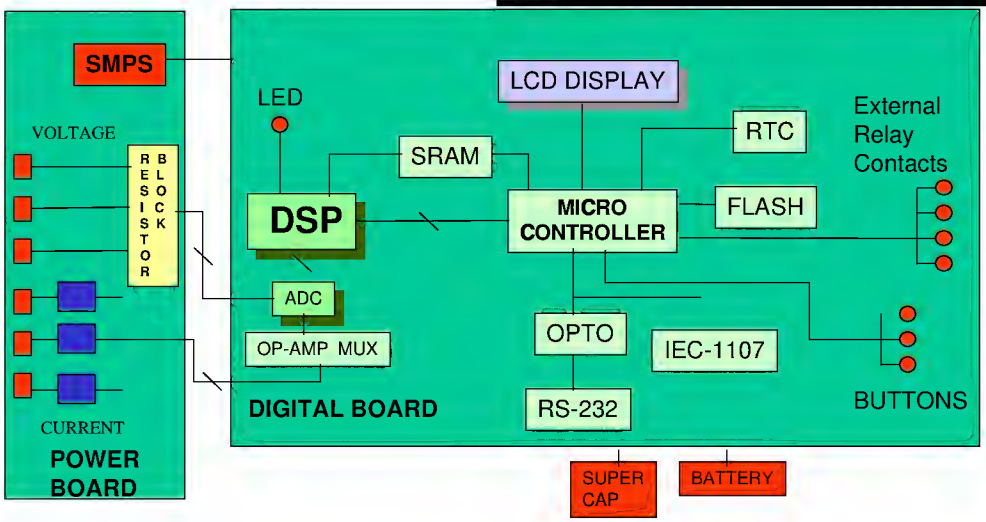
SALEM is a powerful Digital Signal Processor and Micro-Controller based *S*olid State E*l*ectronic Tri-vector *E*nergy *M*eter which satisfies all three-phase power and energy measurement needs. This fully engineered energy meter is ready for production with minimum modifications.

The Digital Signal Processor (DSP) in SALEM acquires the voltage and current signals from the front-end amplifier and analog-to-digital-converter (ADC) stage. The DSP then computes various parameters including RMS values of voltage and current and power factors for each individual phase, active, reactive and apparent power and energy, and the line frequency. The micro-controller collects this computed data from the DSP and calculates maximum, cumulative and rising demand. In addition, the micro-controller also performs data management and peripheral control.

The delay equalization software running on the DSP compensates for the delay in sampling individual channels caused by the multiplexed analog-to-digital-converter.

HIGHLIGHTS

- **An engineered 3-phase, Tri-vector energy meter design**
- **Measures active, reactive and apparent power and energy**
- **Design uses ADSST-EM-3xxx chipset and a micro-controller.**
- **6-channel multiplexed sampling uses 12-bit ADC with delay equalization on sampled data in software**
- **Measurements displayed on a 16x2 LCD display and stored in Flash memory**
- **True RMS measurement of all phase voltages and line currents**
- **Class 0.5 accuracy for active and reactive energy and power measurement. Accuracy maintained for non-sinusoidal and dynamic, unbalanced loads**
- **Computes Maximum, Cumulative and Rising demands**
- **Load survey data can be stored for 150 days at 30 minute intervals**
- **Password protection for configuring and logging data**
- **Meter calibration using PC-based software**
- **Harmonic Analysis optional**



SALEM has been configured for three-phase, four-wire operation with nominal load current of five amperes per phase. This unit can be reconfigured to operate in three-phase, three-wire mode by making minor jumper changes in the hardware and software configuration. SALEM computes and displays the energies and powers with an accuracy of Class 0.5. The meter is useful for export/import metering and can measure capacitive and inductive reactive powers and energies.

The data collected by the micro-controller is periodically stored in a Flash memory. The basic configuration has a storage capacity of 128 Kbytes and can be expanded to 512 Kbytes by replacing the existing chip with a higher capacity Flash memory IC. The hardware need not be re-designed to increase the memory capacity. By adding an external crystal oscillator to the on-board real-time clock, OEMs can choose the accuracy of the time maintained by the meter. A 16x2 LCD display along with two external buttons enables scrolling or selective display of various parameters computed by the meter. The maximum demand can be reset using the external button or through software. The maximum demand can be configured to operate in a fixed window mode with integration period of 15 or 30 minutes or in a slipping/sliding window mode with minimum of 1 minute slipping time.

The micro-controller on SALEM can be configured to store various parameters for four distinct different seasons. The starting time of each season is remotely programmable from an external terminal. To modify any of the parameters, SALEM requires a password. The meter maintains a log of the time, date and operator's code number whenever modifications are made.

The meter is powered from the power line through a three-phase switched mode power supply and would work if at lease one phase is present. The on-board super capacitor is used for running the real time clock. In the event of a black-out, the LiSOC battery powers various sections of SALEM for the operator to access all the data from the meter using an external terminal on the asynchronous connection port.

SALEM is useful for conducting load surveys at any installation and can store various parameters for up to 150 days at 30 minutes intervals.

BASE CONFIGURATION:

- 3-phase 4-Wire, 5 Amps, computation of parameters and storage of energies
- Configurable for 3-phase 3-Wire operation
- 128Kbyte Flash memory expandable to 512KBytes
- Time of Day consumption of active, reactive and apparent energies with 12-programmable time slots per day and tamper proof data
- Maximum, Cumulative and Rising demand data computation
- Maximum Demand integration configurable to fixed window or slipping window method
- Integration period is programmable to 15 or 30 minutes for Maximum Demand computation
- Super capacitor and battery to power up the real- time clock and the micro-controller during a black-out.
- Optional Harmonic Analysis up to 11th Harmonic for all phase voltages and line currents

method in four-wire configuration and two-watt meter method in three-wire configuration for measurement and computation of power and energy. The SALEM software consists of the DSP code and the micro-controller code. These codes reside in the micro-controller and the DSP code is downloaded from the micro-controller on power up.

SALEM consists of five basic sections:

- Signal Conditioning and Acquisition
- Digital Signal Processing

- Micro-controller and Storage
- Communication and Display
- Power Management

SIGNAL CONDITIONING AND ACQUISITION

A resistor divider scales down the phase voltages. The line currents are sensed using current sensors and are passed through the signal conditioning and automatic gain selection circuit to get the desired gain. The 8-channel, multiplexed sampling, 12-bit Analog-to-Digital converter, digitizes the signal conditioned current and voltage signals and sends the serial output data to the serial port of the Digital Signal Processor (DSP).

DIGITAL SIGNAL PROCESSING

The ADSST-EM-3xxx consists of a DSP and a 12-bit Analog-to-Digital Converter. The DSP micro-computer is used for high speed numeric processing applications. The DSP software is downloaded from the micro-controller on power up. The DSP stores the acquired current and voltage signals temporarily in the internal Data Memory for computation of following parameters:

- RMS values of all phase voltages and line currents
- Active and Apparent Power and Energy
- Capacitive and Inductive Reactive Energy and Power
- Power Factor for each individual phase and total power factor
- Frequency

The computed data is temporarily stored in an external SRAM for the micro-computer to process this data and store it in Flash memory.

MICRO-CONTROLLER AND STORAGE

The Micro-controller, 80C51, collects the data computed by the DSP from the SRAM and computes the following parameters:

- Maximum, Cumulative and Rising demands
- Tamper proof data to store Number of Failures, duration of Failures, First failure and last restoration for all phase voltages and line currents

The micro-controller stores various parameters including active, reactive and apparent energies, maximum demand and cumulative demand. These parameters are stored periodically in the 128 Kbyte Flash Memory. The energy and demand values are segregated and stored for four different seasons. The starting time of these four seasons is remotely programmable from an external terminal. Active and reactive energy and demands can be stored periodically at 30-minute intervals for Load Surveys.

DISPLAY AND COMMUNICATION

The computed parameters along with the parameter index are displayed by the micro-controller on a 16x2 LCD display. The external buttons help set the display in a scrolling or selective parameter display mode. The micro-controller controls the LCD module. The display of parameters can be selectively enabled or disabled using control buttons or the configuration software running on a external terminal. The external terminal can be connected to the SALEM using the optically isolated asynchronous communication port, or the IRDA port, or the optional IEC1107 compatible port.

POWER MANAGEMENT

The SALEM is powered by an on-board switched-mode three-phase power supply. The complete unit is operational if any one of the three phases is present. In the event of a black-out, the battery in conjunction with a super capacitor powers the real-time clock. The super capacitor also enables a user to read the meter or download the data during the black-out.

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SOFTWARE FEATURES

SALEM is a totally software-based product and the unit can be interfaced to an IBM PC or compatible for calibration, configuration and monitoring. The firmware, consisting of the DSP and micro-controller code, resides on the micro-controller. The micro-controller up-loads the DSP code to the DSP on power up. The DSP computes all the basic parameters and the micro-controller manages the data and controls all the peripheral components. The meter does not use any trim potentiometers and calibration can be performed by software. Using the PC compatible software, all the parameters can be enabled or disabled for display on the meter. The Current Transformer (CT) and Potential Transformer (PT) ratios can be changed, so that the displayed values will be the actual values fed to the CT and PT. The software enables a user to store the meter ID number. SALEM also provides as an option harmonic analysis and computes magnitude and phase information of all odd harmonics up to 11^{th} harmonic of all current and voltage channels. These values can be displayed on an external terminal using this software. SALEM uses a sequential sampling Analog-to-Digital-Converter and the delay in channel measurement is compensated by delay equalization software.

SPECIFICATIONS

CURRENT:	
SALEM	**5 Amperes per phase**
FREQUENCY:	
Reference	**50 Hz**
Specified Range	**40 - 150 Hz**
VOLTAGE:	
Reference	**3X230 Volts**
Optional configuration	**3X110 Volts**
Specified Range	**168 to 276 Volts**
Measurement Accuracy	**Class 0.5**
Power Consumption	**< 3.8 VA**
HARMONIC ANALYSIS:	**Optional**

Analog Devices, Inc., together with *Signion Systems* are developing the most advanced software system solutions today. These solutions are being engineered by Technology & Research.

All designs using this software must use ADSST-EM-3xxx for ordering the chipset, consisting of a DSP processor and a 12-bit ADC.

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